

U.S.S.N. 10,797,945

Claim Amendments

Please amend claims 18, 32, 33, 38, and 39 as follows:

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Listing of Claims

Claims 1-17 (canceled)

18. (currently amended) A contact interconnect structure comprising:

a semiconductor substrate comprising CMOS devices including active contact regions;

a first contact layer overlying the active contact regions comprising a first plurality of metal filled contact openings extending through the first contact layer thickness to the active contact regions;

a second contact layer overlying the first contact layer comprising a second plurality of metal filled contact openings, each of said second plurality of metal filled contact openings extending through the second contact layer thickness to physically contact a major metal filling portion of a respective one or more of the first plurality of metal filled contact openings;

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wherein, the first plurality and the second plurality of metal filled contact openings form a physically continuous contact interconnect structure, said first and second metal filled contact openings having an aspect ratio of less than about 4.5 with respect to a respective contact layer, said contact interconnect structure connecting said active contact regions to overlying wiring circuitry comprising metallization layers, said first and second metal filled contact openings not comprising wiring grooves.

19. (previously presented) The contact interconnect structure of claim 18, wherein the bottom portion of said contact interconnect structure has a maximum width of less than about 70 nanometers and an aspect ratio of less than about 4.5.

20. (previously presented) The contact interconnect structure of claim 18, further comprising an overlying metallization layer in electrical communication with the second plurality of metal filled contact holes.

21. (previously presented) The contact interconnect structure of claim 18, wherein the first and second contact layers are selected from the group consisting of PETEOS, BPTEOS, BTEOS,

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PTEOS, TEOS, PEOX, nitrogen doped silicon oxide, fluorine doped silicon oxide, SiC, silicon nitride, and silicon oxynitride.

22. (previously presented) The contact interconnect structure of claim 18, wherein the first and second contact layers comprise lowermost portions selected from the group consisting of silicon carbide, nitrogen doped silicon oxide, silicon nitride, and silicon oxynitride.

23. (canceled)

24. (previously presented) The contact interconnect structure of claim 18, wherein the first plurality and the second plurality of metal filled contact openings comprise conductive materials selected from the group consisting of Cu, W, Al, AlCu, TiN, TiW, Ti, TaN, and Ta.

25. (original) The contact interconnect structure of claim 18, wherein the active contact regions are selected from the group consisting of source and drain regions and gate electrodes.

26. (previously presented) The contact interconnect structure of claim 25, wherein the gate electrode comprises a gate structure

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having a gate length of less than about 45 nm.

27. (original) The contact interconnect structure of claim 18, wherein the active contact regions comprise a conductive material selected from the group consisting of Ti, Co, Ni, Pt, W, TiSi_2 , CoSi_2 , NiSi , PtSi , WSi_2 , TiN , and TaN .

28. (previously presented) The contact interconnect structure of claim 18, wherein the first and second contact layers comprises an uppermost portion selected from the group consisting of a hardmask layer and a BARC layer.

29. (previously presented) The contact interconnect structure of claim 18, wherein the first and second plurality of metal filled contact openings comprise a shape selected from the group consisting of circular and rectangular shape.

30. (previously presented) The contact interconnect structure of claim 18, wherein the first and second plurality of metal filled contact openings are selected from the group consisting of vias, contact holes, butt contact interconnects, and local interconnects.

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31. (canceled)

32. (currently amended) A contact interconnect structure comprising:

at least first and second stacked contact layers comprising a respective first and second plurality of metal filled contact openings, extending through the respective first and second contact layers, each of said second plurality of metal filled contact openings extending to a respective contact region comprising an active transistor region, each of said first and second plurality of metal filled contact openings forming physically contacting a respective one of said second plurality of metal filled contact openings, said physical contact through major metal filling portions comprising said stacked contact interconnect structure first and second plurality of metal filled contact openings;

wherein, the first plurality and the second plurality of metal filled contact openings comprise a bottom portion having a maximum width of less than about 70 nanometers, said first and second metal filled contact openings having an aspect ratio of

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less than about 3.3 with respect to a respective contact layer, said ~~contact interconnect structure~~ first and second plurality of said metal filled contact openings connecting said active contact regions to overlying wiring circuitry comprising metallization layers, said first and second plurality of said metal filled contact openings not comprising wiring grooves.

33. (currently amended) The contact interconnect structure of claim 32, wherein the a bottom portion comprising the second plurality of metal filled contact openings has a maximum width of less than about 50 nanometers and an aspect ratio of less than about 4.5.

34. (previously presented) The contact interconnect structure of claim 32, wherein the first and second contact layers comprise an ~~underlying-etch~~ stop layer.

35. (previously presented) The contact interconnect structure of claim 32, wherein the active transistor region is selected from the group consisting of source and drain regions and gate electrodes.

36. (original) The contact interconnect structure of claim 35,

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wherein the gate electrode comprises a gate structure having a gate length of less than about 45 nm.

37. (canceled)

38. (currently amended) A stacked contact interconnect structure for achieving a high aspect ratio comprising:

a semiconductor substrate comprising CMOS devices including active contact regions;

a first contact layer overlying the active contact regions, said first contact layer comprising a first metal filled contact opening hole extending through the first contact layer thickness to the active contact regions;

a second contact layer overlying the first contact layer, said second contact layer comprising a second metal filled contact opening hole extending through the second contact layer thickness to physically contact a major metal filling portion of the first metal filled opening;

wherein, each of the first and second metal filled contact

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~~openings~~ holes have about the same width to form a physically connected stacked contact interconnect structure, said first and second metal filled contact ~~openings~~ holes having an aspect ratio of less than about 4.5 with respect to a respective contact layer, said ~~contact interconnect structure~~ first and second metal filled contact holes connecting said active contact regions to overlying wiring circuitry comprising metallization layers.

39. (currently amended) The contact interconnect structure of claim 38, wherein ~~the~~ a bottom portion of said contact interconnect structure comprising said second metal filled contact hole has a maximum width of less than about 70 nanometers and an aspect ratio of less than about 4.5.

40. (previously presented) The contact interconnect structure of claim 38, wherein the first and second contact layers are selected from the group consisting of PETEOS, BPTEOS, BTEOS, PTEOS, TEOS, PEOX, nitrogen doped silicon oxide, fluorine doped silicon oxide, SiC, silicon nitride, and silicon oxynitride.

41. (previously presented) The contact interconnect structure of claim 38, wherein the first and second contact layers each comprise a lowermost etch stop layer selected from the group

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consisting of silicon carbide, nitrogen doped silicon oxide, silicon nitride, and silicon oxynitride.

42. (previously presented) The contact interconnect structure of claim 38, wherein the first plurality and the second plurality of metal filled contact openings comprise conductive materials selected from the group consisting of Cu, W, Al, AlCu, TiN, TiW, Ti, TaN, and Ta.

43. (previously presented) The contact interconnect structure of claim 38, wherein the active contact regions are selected from the group consisting of source and drain regions and gate electrodes.

44. (previously presented) The contact interconnect structure of claim 38, wherein the active contact regions comprise a conductive material selected from the group consisting of Ti, Co, Ni, Pt, W, TiSi₂, CoSi₂, NiSi, PtSi, WSi₂, TiN, and TaN.

45. (previously presented) The contact interconnect structure of claim 18, wherein the first plurality and the second plurality of metal filled contact openings comprise the same major metal filling material.

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46. (canceled)

47. (previously presented) The contact interconnect structure of claim 32, wherein the first plurality and the second plurality of metal filled contact openings comprise the same major metal filling material.

48. (canceled)

49. (currently amended) The contact interconnect structure of claim 38, wherein the first plurality and the second plurality of metal filled contact ~~openings~~ holes comprise the same major metal filling material.

50. (canceled)